

703 CONCRETE FOR STRUCTURES

703.01 DESCRIPTION

Concrete for structures shall consist of portland cement concrete used in structures constructed in conformity with the lines, grades and dimensions as shown on the plans or as specified by the Engineer. This item shall also include, where applicable, furnishing and installing emblems and reference marks, setting of all necessary anchor bolts, and installing manhole frames and covers.

703.02 MATERIALS

PCC Concrete Mixtures - 817, Class A or B

Curing materials - 814.01, 814.02(A), 814.02(C), 814.03

Preformed joint filler - 807.01(B)

Waterstop - 807.05

Epoxy - 821.10

Epoxy mortar - 806.05(C)

703.03 PROPORTIONING

The Contractor shall submit a mix design conforming to 817.01 for the approval of the Engineer. The approved mix design shall not be changed except as provided below.

1. Adjustment for variation in fineness modulus (FM). If the FM of the fine aggregate varies by more than 0.20 from the established value, the mix design shall be adjusted as provided in 817.01.

2. Adjustment for variation in workability. If it is impossible to obtain PCC of the desired workability with proportions approved by the Engineer, the Contractor shall make such changes in aggregate weights as necessary, provided that in no case shall the cement content originally designated be changed except as provided below.

3. Adjustment for variation in consistency. If it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable water-cement ratio specified, the cement content may be increased as approved by the Engineer so that the maximum allowable water-cement ratio will not be exceeded.

4. Adjustment for variation in yield. If cement content of the PCC determined by AASHTO T 121 varies more than plus or minus 2 percent from the approved design mix, the proportions shall be adjusted by the Contractor and approved by the Engineer to maintain a cement content within these limits. The water content shall not exceed the maximum approved.

5. Adjustment for new materials. Change in source or character of the materials shall be made only after tests on trial mixes and with the Engineer's written approval.

Aggregates and portland cement shall be proportioned by weight. Water may be proportioned by volume or by weight. Batch weights of aggregates for the concrete shall be corrected for free moisture, as calculated from moisture determinations performed by the Contractor and witnessed by the Engineer. These moisture

determinations shall be made as frequently as deemed necessary by the Engineer.

Suitable means shall be provided for accurately determining the amount of moisture in the aggregates.

703.04 HANDLING, MEASURING AND BATCHING MATERIALS

The supplier of the concrete shall have sufficient plant capacity and transportation apparatus to provide delivery at the rate required to insure that the depositing of the concrete will be continuous.

Stockpiles shall be built up in layers of not more than 3 feet in thickness. Each layer shall be completely in place before beginning the next, which shall not be allowed to come down over the next lower layer. Aggregates from different sources and of different gradings shall not be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to minimize segregation of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or nonuniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Engineer.

The fine aggregate and each size of coarse aggregate shall be separately weighed into hoppers in the respective amounts conforming to the approved mix design. Cement shall be measured by weight. Separate scales and hoppers shall be used for weighing the cement with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Batching shall be so conducted as to result in weights of each material required within tolerances of plus 4 percent for cement, +/- 2 percent for aggregates, and +/- 1 percent for water. The accuracy of measuring the water shall be within a range of error of not over 1 percent.

Unless otherwise permitted by the contract, batching plants shall be equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved type.

Methods and equipment for adding air-entraining agent or other admixtures to the batch, when required, shall be approved by the Engineer. All admixtures shall be measured into the mixes within a tolerance of plus or minus 3 percent.

703.05 MIXING CONCRETE

(A) GENERAL. The concrete may be mixed wholly or in part in paving mixers, stationary mixers or truck mixers located at a central plant or at the site. Ready-mixed concrete shall conform to the requirements of AASHTO M 157. Concrete mixed under these specifications shall be of uniform consistency and such that the mortar will bond to the coarse aggregate. It shall not be sufficiently wet to flow readily or segregate, nor shall it be of a mealy or too dry consistency.

The interval between batches shall be such that the concrete in place does not partially harden and in no case shall this interval exceed 30 minutes. The time interval between admission of cement to the aggregate and final discharge of the concrete shall not exceed one and one-half hours. The time interval shall not exceed one hour for hot weather (85°F or above) construction. Concrete which has developed an initial set shall not be used. Retempering of partially set concrete by mixing with additional water is prohibited.

Delivery of concrete materials shall be controlled by tickets issued to the driver and signed by the authorized representative of the Engineer at the plant. These tickets shall contain information as directed by the Engineer. Upon arrival at the job site, the tickets shall be given to the Engineer.

(B) TRUCK MIXING. Truck mixers shall meet the requirements of 905.

All wash water shall be dumped before reloading the truck with concrete or concrete materials. No truck shall be loaded which contains free water in the drum. In depositing aggregates into the mixer drum, and in fastening the charging gate, no free water in excess of that found in the moisture determinations shall be admitted into the mixer drum.

Mixing water and wash water for truck mixed PCC shall be stored in watertight tanks, separate from the mixing drum. Each tank shall be equipped with an approved, operable, calibrated gauge. Water tanks shall be completely filled at the plant. If, on arrival at the job, inspection reveals a drop in the water level, the batch may be rejected. All mixing water, other than free moisture in the aggregates, shall be added to the mix in the presence of the Engineer. Prior to adding mixing water to the drum the mixing water gauge valve shall be set to show the water level in the tank, and the gauge shall be read and recorded in the presence of the Engineer. No wash water shall be used until all concrete in the drum has been discharged.

The Contractor shall provide a level area for all truck mixing.

After all materials, including water, have been added to the mixing drum, mixing shall be in accordance with latest recommendations of the mixer manufacturer for a minimum of 70 and a maximum of 100 revolutions excluding revolutions at the agitation speed. The mixing speed shall not be less than 4 rpm and not more than 18 rpm.

If the slump is less than that desired, additional water may be added if permitted by the Engineer. After addition of the water, the mixing drum shall be rotated 20 to 30 revolutions at the mixing speed before the discharge of the concrete. After the addition of water the number of revolutions shall not exceed 100, except for concrete mixes containing coarse aggregates which do not wear more than 25 as determined in accordance with Resistance to Abrasion of Small Size Coarse Aggregate, AASHTO T-96, for which the number of revolutions shall not exceed 130.

The rate of discharge of concrete from the mixer drum shall be controlled by the speed of rotation in the discharge direction with the discharge gate fully open.

(C) TRANSIT MIXING. Transit mixing shall be in accordance with 703.05(B) except:

Mixing water shall be accurately measured at the proportioning plant and added to the mixing drum at the plant. Mixing may be done at the plant or at the job site, at the option of the Contractor. In either case, the mixer drum shall be rotated at the agitation speed from the time the truck leaves the plant until it arrives at the job site.

(D) CENTRAL MIXING. When central mixing is used, the proportioning and mixing plant shall meet all the requirements governing the handling, proportioning and mixing of concrete materials in a stationary mixer in conformance with AASHTO M 157.

The mixed concrete shall be conveyed from the central mixing plant to the site of the work in agitator or nonagitator trucks conforming to 905.02. The time elapsing from the time cement is added to the mix until the

concrete is deposited in place at the site of work shall not exceed 45 minutes when the concrete is hauled in nonagitating trucks, nor 90 minutes when hauled in truck mixers or truck agitators, except that in hot weather (85°F or above) the time interval shall not exceed one hour.

(E) PAVING MIXERS. Paving mixers having a rated capacity of 27 cubic feet or over may be used when approved by the Engineer.

(F) HAND MIXING. Hand mixed batches of concrete may be allowed only in an emergency. The total quantity of such batches shall not exceed 1/2 cubic yard. Hand mixing shall be subject to the immediate direction and approval of the Engineer.

703.06 TESTING AND ACCEPTANCE

(A) CONSISTENCY. The consistency of the concrete will be checked by the slump test in conformance with AASHTO T 119. Maximum slump shall be as specified in 817.03(B). The determination will be made when and as often as deemed necessary by the Engineer to check the consistency of the concrete. The Contractor shall provide a slump cone, rod and a flat, non-absorbent surface in conformance with AASHTO T 119, for each project.

(B) AIR CONTENT. Air content of plastic concrete shall be tested in conformance with AASHTO T 196 or AASHTO T 152 as determined by the Engineer. The entrained air shall be as specified in 817.03(B).

(C) COMPRESSIVE STRENGTH. Test cylinders will be made from each class of concrete, at the direction of the Engineer. Concrete for such specimens shall be furnished by the Contractor as directed.

Concrete test specimens for compression strength testing shall be made and cured in accordance with AASHTO T 23. Compressive strength shall be tested in conformance with AASHTO T 22. Unless otherwise specified, the minimum 28 day compressive strength shall be in accordance with 817.03(B). The Contractor shall provide cylinder curing facilities at the project site that will allow initial 24 hour curing to be in conformance with AASHTO T 23, Section 7.2.

(D) PUMPED CONCRETE. When concrete is pumped, concrete will be sampled for conformance to the consistency requirements before pumping and before the addition of approved admixtures, which are added at the site after initial mixing. Concrete will be sampled for air content before pumping. However, the air content will be adjusted to compensate for changes in the air content which occur during pumping as determined by the Engineer.

703.07 WEATHER RESTRICTIONS AND NIGHT WORK

(A) HOT WEATHER CONSTRUCTION. The maximum temperature of concrete for bridge decks, approach slabs and other structural slabs shall be 85°F. The maximum temperature of concrete used for other structures shall be 90°F. If the required consistency cannot be maintained, the mix shall be adjusted in accordance with 703.03. The temperature of the cement at the time of batching shall not exceed 160°F.

(B) COLD WEATHER CONSTRUCTION. When the forecast of the U.S. Weather Bureau indicates that the temperature is expected to be less than 50°F during the 24 hour period following the placing of the concrete, a Type C accelerator meeting the requirements of 814.05(A) shall be incorporated in the concrete mix at the batching plant.

No concrete shall be placed without permission of the Engineer when the ambient temperature reaches 40°F and is descending or when the U.S. Weather Bureau forecasts that the temperature will drop below 40°F during the 24 hour period following the placing of the concrete. If the Engineer permits concrete placement at temperatures lower than those specified above, the following requirements shall be met:

1. The temperature of the mixed concrete shall not be lower than 50°F and not more than 90°F at the time of placement.

2. When directed by the Engineer, the Contractor shall enclose and heat the structure in such a way that the concrete and air within the enclosure is kept above 55°F for a period of 7 days after placing concrete. When dry heat is used, means of maintaining atmospheric moisture shall be provided.

In lieu of enclosing and heating the structure, approved form insulation may be used for concrete other than deck slabs. Form insulation shall be completely enclosed in a waterproof material which shall be maintained in a good and serviceable condition at all times. The blanket shall be applied tightly against the forms in an approved manner so as to exclude air and moisture. Both horizontal and vertical surfaces shall be covered and care shall be taken to see that all edges and corners are properly covered. If necessary, the tops of placements shall be protected by a tarpaulin or other waterproof cover over the insulation. The insulation shall be capable of maintaining the temperature of the concrete in the forms between 55°F and 100°F for a period of at least 7 days. At the end of the protection period the temperature of the concrete within the forms shall be gradually decreased at a rate of cooling not to exceed 20°F per 24 hours by gradually loosening the forms or insulation.

3. No concrete shall be placed on frozen grade nor shall frozen aggregates be used in the concrete.

No direct payment will be made for incorporating an accelerator in the concrete or for the insulated curing required for cold weather construction. The cost of this work will be included in the contract price for the various portland cement concrete pay items.

The Contractor will be held responsible for any defective work caused by freezing. Concrete damaged in any manner shall be removed and replaced without cost to the District of Columbia.

(C) WIND. No deck concrete placement shall be scheduled or started when it is anticipated that the wind velocity, excluding gusts, will exceed 15 M.P.H. as forecast by the National Weather Service.

(D) NIGHT WORK. Concrete for bridge decks, approach slabs and other structural slabs shall be placed at night from June 1 through September 15. During this period concrete placement operations shall be scheduled so that no concrete shall be placed before 9:00 PM and all concrete shall be deposited within the forms before 7:30 AM. Regardless of the date, no concrete placement shall be scheduled when it is anticipated that the temperature at an unshaded location within the placement site will exceed 80°F.

No other concrete shall be placed during night hours unless specified in the contract or permitted by the Engineer.

An adequate lighting system shall be provided during nighttime construction for both placement operations and inspection testing. A minimum of 20 footcandles illumination at the slab elevation shall be provided at all areas within the placement site. A suitable light meter shall be provided to measure the illumination. A lighting plan shall be submitted to the Engineer for approval. In addition, before any initial slab placement operation, a test run shall be made to insure that the specified illumination is provided. If a portable generator is used, an emergency backup generator shall be available at the job site.

703.08 PLACING CONCRETE

No concrete shall be placed until the depth and character of the foundation, the adequacy of the forms and falsework, and the placing of reinforcing steel have been inspected and approved by the Engineer. Such approval shall not relieve the Contractor from responsibility for satisfactory performance of his work.

The Contractor shall ascertain that a sufficient supply of concrete to completely fill the forms without interruption will be available before starting the placement of concrete. The concrete delivery and placement rate shall be approved by the Engineer and shall be such that no previously placed batch is allowed to partially harden before the placement of the subsequent, adjacent batch.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes, and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization of the Engineer. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing.

Open troughs and chutes shall be of metal or metal lined. Where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than 5 feet, it shall be deposited through sheet metal or other approved pipes. Pipes shall be so constructed so that concrete is not allowed to free-fall more than 5 feet. Pipes will not be required for walls 2 feet thick and under.

In preparation for the placing of concrete, all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of the forms.

Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.

Special care shall be taken to fill each part of the forms by depositing the concrete as near the final position as possible. Working or flowing of concrete along the forms from the point of deposit will not be permitted.

In case of emergency shutdown, steps shall be taken, as required by the Engineer, to prevent detrimental effects on placing operations. For bridge deck concrete, the Contractor shall provide a suitable construction joint by use of a bulkhead to the satisfaction of the Engineer. Excess concrete shall be removed from the forms and disposed of properly.

Struts, stays, and braces serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete. After the initial set of the concrete, the forms shall not be jarred, and no strain shall be placed on the ends of reinforcing bars which project.

Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcing steel, anchor bolts and the surface of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcing steel.

703.09 CONSOLIDATION

Concrete, during and immediately after depositing, shall be thoroughly consolidated. Consolidation shall be done by mechanical vibration subject to the following provisions.

The vibration shall be internal unless special authorization of other methods is given by the Engineer, or as provided herein.

Vibrators shall be of a type and design approved by the Engineer and shall be capable of transmitting vibration to the concrete at frequencies of not less than 5,000 impulses per minute. The intensity of vibration shall be such as to visibly affect a mass of concrete of one (1) inch slump over a radius of at least 18 inches.

The Contractor shall provide a sufficient number of vibrators to properly consolidate each batch immediately after it is placed in the forms. The size of the vibrator shall be governed by the space available for its use in the forms and between reinforcing bars.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly consolidate the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective, or not more than 3 feet apart throughout the mass of concrete. Vibrations shall be transmitted directly to the concrete and in no case shall they be transmitted through the forms.

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms.

Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into corners and angles of the forms.

Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

Each layer shall be placed and consolidated before the preceding layer has taken initial set to prevent the formation of a cold joint between layers.

703.10 PLACING CONCRETE BEHIND STONE MASONRY

No concrete shall be placed back of stone masonry for the first 24 hours after the stone has been set and until the mortar in the masonry has set sufficiently to withstand the pressure of fresh concrete. The concrete shall be placed in such a manner as to avoid damaging pressures on the stone masonry.

Anchorage and bracing shall be outlined in 708.09 and 708.10(F). The requirements for bonding concrete to stone masonry shall be outlined in 708.10(E).

703.11 DEPOSITING CONCRETE UNDERWATER

Concrete shall not be exposed to the action of water before setting and shall not be deposited underwater except with the approval of the Engineer and under his immediate supervision, and, under his conditions, the method of placing shall be as designated herein.

Concrete deposited underwater shall be tremie concrete. Tremie concrete shall be carefully placed in a compact mass in its final position by means of tremie pipes in such manner as to produce a continuous, complete monolith of concrete without joints, of the full area of the foundation and of the thickness required, and concrete shall not be disturbed after being deposited. Concrete shall be deposited only under still water and in forms or cofferdams which are substantially watertight.

The cement content of concrete to be placed underwater shall be increased by 10 percent over that of comparable concrete placed above water.

Concrete deposited as seal courses of foundation bases shall be placed in continuous operations without any cessation, and if necessary, both day and night without midday or other stops until the entire mass of the seal has been placed. Adequate plant and supplies of material shall be on hand to assure such continuous operation. The concrete plant shall be so arranged that breakdown of any piece of equipment will not necessitate complete shutdown. Depositing shall be so distributed in the area of placement that the surface of the concrete shall be kept as horizontal as practicable at all times.

Tremies shall consist of watertight tubes, preferably of steel pipe about 10 inches in diameter constructed in sections having screwed joints of flanged couplings fitted with gaskets, and fitted at the top end with a hopper. Tremie tubes shall be sufficiently long so that when set on the bottom of the excavation where concrete is to be deposited the hopper shall extend above the water. Tremies shall be supported so as to permit proper filling of the hoppers and so that the tremie can be raised vertically with a slow movement and lowered rapidly to retard the flow of concrete. The discharge end of each tremie tube shall, unless otherwise permitted by the Engineer, be equipped with an approved automatic check valve. At the start of the work, the check valve shall be closed to prevent water from entering the tube and thereafter the discharge end shall be entirely sealed at all times by being set upon the bottom of the excavation or upon concrete already deposited and the tremie tube shall be kept full to the bottom of the hopper. When a batch of concrete is dumped into the hopper, the tremie shall be slowly raised but not out of the concrete at the bottom of the tremie and until the batch discharges to the bottom of the hopper; the tremie shall then be quickly lowered and the flow of concrete stopped.

A sufficient number of tremies shall be provided for each foundation so that the lateral flow from any tremie shall not exceed 10 feet unless otherwise approved by the Engineer. The sequence of depositing concrete in tremie pipes shall be as directed by the Engineer. The interval between depositing one batch of concrete in a given tremie and depositing the next batch therein in no case shall exceed 15 minutes and preferably shall be more rapid.

Placement of underwater concrete by means of bottom dump buckets will not be permitted.

After concrete is placed and succeeding courses have properly hardened, the water shall be pumped out and any laitance which may have accumulated on the concrete or any defective concrete which is exposed shall be removed and the surface suitably prepared for additional concrete.

The Contractor's attention is directed to the fact that the elevation of the completed surface on the top of the seal must be such that the required elevations noted in the contract documents for the substructure can be maintained. When necessary to maintain this elevation, the Contractor shall be required to chip away the concrete, and any costs incidental thereto will be at the sole expense of the Contractor.

703.12 PUMPING CONCRETE

Placement of concrete by pumping will be permitted only if authorized by the Engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete. When concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipe line, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. Aluminum pipes shall not be permitted for placing concrete.

The slump of concrete to be pumped shall not be increased by the addition of water such that the slump exceeds the maximum limits of 817. In no case shall the maximum water-cement ratio be exceeded as allowed in the approved mix design. If approved by the mix design, the slump may be increased by the use of admixtures.

703.13 CONSTRUCTION JOINTS

Construction joints shall be made only where indicated on the plans, unless otherwise approved by the Engineer. If not detailed on the plans, or in case of emergency, construction joints shall be placed as directed by the Engineer. Shear keys or inclined reinforcement shall be used, where directed, to transmit shear or to bond the two sections together.

Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened. The surface of the hardened concrete shall be roughened as required by the Engineer in a manner that will not leave loosened particles of aggregate or damaged concrete at the surface. It shall be thoroughly cleaned of foreign matter and laitance, and saturated with water. To insure an excess of mortar at the juncture of the hardened concrete and the newly deposited concrete, the cleaned and saturated surfaces, including vertical and inclined surfaces, shall first be thoroughly covered with a coating of mortar or neat cement grout against which the new concrete shall be placed before the grout has attained the initial set.

The placing of concrete shall be carried continuously from joint to joint. Whenever the Engineer so directs, the Contractor shall be required to place chamfer strips for vertical or horizontal construction joints so that the joint in the finished concrete will show as a V-notch. Such demarcation of construction joints shall be that produced by using 3/4 inch chamfer strips. All chamfer strips shall be milled lumber. Where construction joints are not notched as described above, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel to avoid irregularity in the joint on exposed faces.

Where a "featheredge" might be produced at a construction joint, as in the sloped top surface of a wall, an insert formwork shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than 6 inches in the succeeding layer. Work shall not be discontinued within 18 inches of the top of any face.

703.14 WOOD CONCRETE FORMS

(A) GENERAL. Concrete form drawings and calculations shall be prepared by or under the direction of a Registered Professional Engineer and shall bear his P.E. seal. Forms shall be designed in accordance with the criteria specified herein.

(B) FORM DESIGN.

(1) GENERAL. All lumber shall be stress-graded and the grade shall be stamped or branded on the lumber. The supplier shall submit certifications for the grades of lumber supplied. Working stresses used in form design shall not exceed allowable stresses for the grade of lumber furnished.

(2) LOADS. Loads for design shall be in accordance with paragraph 2.2 of the American Concrete Institute Standard Recommended Practice for Concrete Formwork (ACI 347).

(3) UNIT STRESSES. Unit stresses for lumber shall be in accordance with the National Forest Products Association Publication titled "Design Values for Wood Construction."

(4) DEFLECTION. Maximum deflections for each form member shall not exceed the following:

Exposed walls, abutments, piers, parapets and curb	L/360
Unexposed (stone-veneered) walls, etc.	L/270
Decks and footings	L/180

(5) GENERAL DESIGN INFORMATION. Investigation of the strength and stiffness requirements of lumber components shall be made in accordance with the National Forest Products Association National Design Specifications and its manual titled "Wood Structural Design Data." Adjustment of working stresses shall be made in accordance with the NDS.

Plywood thickness and joist or stud spacing shall be in accordance with Table 703.14. Metal ties, hangers and other hardware shall be designed in accordance with the manufacturer's recommendations.

TABLE 703.14 MAXIMUM STUD OR JOIST SPACING (Inches)

		Plywood Thickness					
Form Pressure (psi)		5/8-inch			3/4-inch		
		<u>Allowable Deflection</u>			<u>Allowable Deflection</u>		
		<u>L/360</u>	<u>L/270</u>	<u>L/180</u>	<u>L/360</u>	<u>L/270</u>	<u>L/180</u>
100 and less	22	24	26	24	28	32	
200	18	20	22	20	232	26	
300	16	17	18	18	20	22	
400	14	15	16	16	18	19	
500	13	14	15	15	16	17	
600	12	13	14	14	15	16	
700	11	13	14	13	15	15	
800	11	12	13	13	14	14	

900	10	11	12	12	13	13
1000	9	11	11	12	12	12
1100	use 3/4"	10	10	11	12	12
1200	"	10	10	11	11	11
1300	"	10	10	11	11	11
1400	"	9	9	11	11	11
1500	"	use 3/4"	use 3/4"	10	10	10

1. Table assumes plywood is continuous over two or more spans. For simple spans, use 200: or the value of the computed form pressure.
2. Table assumes plywood face piles are parallel to the span. If plywood face piles are parallel to supports use 200: or the value of the computed form pressure for 5\8-inch plywood. 133: for 3\4-inch plywood.
3. Table is for plywood having stress values of $f = 2000$ psi and $E = 1,600,000$ psi.

(C) CONSTRUCTION METHODS. All concrete shall be placed in suitable forms or against excavated earth surfaces. The latter procedure will be allowed only if expressly permitted by the Engineer. Forms shall be of wood or metal and shall be built mortartight. Forms for exposed surfaces shall be so constructed that the surface of the concrete will be smooth and uniform in appearance.

Lagging for the bottom forms of rigid frames or arches shall be not less than 1-1/4 inch nominal thickness for joists spaced 21 inches to 24 inches, and not less than 1 inch nominal thickness for joists spaced 20 inches or less and shall be lined with 3 ply plywood. Curved surfaces shall accurately follow the required radii. Forms shall be mitered at all sharp corners and shall be given a bevel or draft for all projections, such as girders and copings, to insure easy removal.

Plywood sheets for form lining on exposed surfaces shall be placed symmetrically between joints, for symmetry in appearance of the concrete surface.

Temporary openings shall be provided at the bottom of the forms for narrow walls and piers where necessary to facilitate cleaning before depositing concrete.

Suitable milled triangular beveled moldings approximately 3/4 inch on the square sides of such size as directed, shall be placed in the angles for the forms to chamfer the exposed edges of the concrete, including the abutting edges of expansion joints.

Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 2 inches from the face without injury to the surface of the concrete by spalling or otherwise. In exposed surfaces or concrete, metal ties or anchorage shall not be fitted with any lugs, cones, washers or other device to act as a spreader within the forms, or which will leave a hole larger than 7/8 inch diameter or a depression. Ties designed to break off back of the surface of concrete will not be permitted. Wire ties will not be permitted. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size.

All forms shall be set and maintained true to the line designed until the concrete has sufficiently hardened. Forms shall remain in place for periods which shall be determined as specified herein. When forms appear to be unsatisfactory in any way, either before or during placing of concrete, the Engineer will order the

work stopped until the defects have been corrected.

The shape, strength, rigidity, watertightness and surface smoothness of reused forms shall be maintained at all times. Any warped or bulged lumber must be resized before being reused. Forms which are unsatisfactory in any respect shall not be reused.

The inside surface of forms shall be soaked with clean water and kept wet for 12 hours before any concrete is placed. In case forms have been erected for some time and have become dry so that joints have opened then the forms shall be thoroughly soaked until the joints have closed. Forms for exposed surfaces and forms intended to be reused shall be treated with oil before erection of the forms or before placing reinforcing steel in the forms. The oil used for this purpose shall be a clear, paraffin base oil which will not stain or discolor the concrete surface. Excess oil shall be wiped off with rags to leave the surface of the forms just oily to the touch.

703.15 TEMPORARY STEEL BRIDGE DECK FORMS

(A) GENERAL - The use of temporary steel forms in constructing the new bridge deck shall be optional. These forms shall be considered temporary for construction of the deck and shall be promptly removed when the deck has obtained sufficient strength to support all anticipated loads.

(B) MATERIALS - Temporary steel bridge deck forms and supports shall be fabricated from steel conforming to ASTM Specification A446 (Grade A through E) having a coating class of G165 according to ASTM Specification A525.

(C) DESIGN - The following criteria shall govern the design of temporary steel bridge deck forms:

(1) The steel forms shall be designed on the basis of form dead load, reinforcement and plastic concrete plus 50 pounds per square foot for construction loads. The unit working stress in the steel sheet shall be not more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 36,000 pounds per square inch.

(2) Deflection under the weight of the forms, the plastic concrete and reinforcement shall not exceed 1/180 of the form span or 1/2 inch, whichever is less, but in no case shall this loading be less than 120 PSF total. The permissible form camber shall be based on actual load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.

(3) The design span of the form sheets shall be the clear span of the form plus 2 inches measured parallel to the form flutes.

(4) Physical design properties shall be computed in accordance with requirements of the American Iron and Steel Institute Specification for the Design of Cold Formed Steel Structural Members, latest published edition.

(5) Bottom reinforcement shall have a minimum concrete cover of 1 inch.

(6) The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.

(7) Temporary steel bridge deck forms shall not be considered as lateral bracing for compression flanges

of supporting structural members.

(8) Temporary steel bridge deck forms shall not be used in panels where longitudinal deck construction joints are placed between stringers.

(9) Welding to structural steel shall not be permitted. Forms shall be attached to steel members by the use of clamps or other approved mechanical devices which make the forms easily removable without the application of heat.

(10) Fabrication, shop and erection drawings shall be submitted to the Engineer for approval. These plans shall indicate the grade of steel, the physical and section properties for all temporary steel bridge deck form sheets and a clear indication of locations where the forms are supported by steel beam flanges subject to tensile stresses.

(D) CONSTRUCTION - All forms shall be installed in accordance with approved fabrication and erection plans.

Form sheets shall not be permitted to rest directly on top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1 inch at each end. Form supports shall be placed in direct contact with the flange of stringer or floor beam. All attachments shall be made by permissible bolts, clips, or other approved means. The attachments shall be designed to facilitate easy removal of the temporary steel deck forms. Welding shall not be permitted.

(E) PLACING OF CONCRETE - Concrete shall be placed in accordance with the contract specifications. Particular emphasis should be placed on proper vibration of the concrete to avoid honeycombs and voids, especially at construction joints, expansion joints, and valleys and ends of form sheets. Placement sequences, procedures and mixes shall be approved by the Engineer.

Calcium chloride or any other admixture containing chloride salts shall not be used in the concrete placed on temporary steel bridge deck forms.

When, in the opinion of the Engineer, the concrete bridge deck has attained sufficient strength to support all anticipated dead and live loads, the temporary steel bridge deck forms shall be removed and properly disposed of by the Contractor.

(F) INSPECTION - The Contractor's method of construction shall be carefully observed during all phases of the construction of the bridge deck slab. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures; concrete placement, vibration and finishing of the bridge deck and removal of the forms. Should the Engineer determine that the procedures employed during concrete placement warrant inspection of the underside of the deck, the Contractor shall remove at least one section of the forms at locations and times selected by the Engineer for each span in the contract. This should be done as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the Contractor's procedures are obtaining the desired results. An additional section shall be removed if the Engineer determines that there has been any change in the concrete mix or in the Contractor's procedures warranting additional inspection.

After the deck concrete has attained adequate strength, the forms shall be removed and disposed of properly. This removal is considered part of the required work and shall be at no additional cost to the District.

As soon as the forms are removed, the concrete surface will be examined for cavities, honey-combing and other defects. If irregularities are found and it is determined by the Engineer that these irregularities do not justify rejection of the work, the concrete shall be repaired as the Engineer may direct and shall be given an Ordinary Surface Finish in accordance with the concrete specifications.

The Contractor shall provide all facilities as are reasonably required for the safe and convenient operation of the Engineer's inspection procedures.

703.16 FALSEWORK AND CENTERING

(A) DESIGN - The Contractor shall engage the services of a professional engineer (P.E.) registered in the District of Columbia, which P.E. shall have a minimum of five (5) years experience in falsework design for bridge construction and repair, to design the falsework for the project.

In the event there is more than one structure in the project, each structure shall require a separate falsework design analysis as specified herein. This requirement applies even when structures appear to be identical.

All falsework shall be designed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Falsework shall be set with the necessary camber so that the completed structure will be true to the lines and grades shown in the contract documents. Suitable means shall be provided to take up any settlement in the falsework either before or during the placing of concrete.

Each falsework system shall be designed to have the capacity to support all vertical and horizontal loading with enough redundancy to prevent progressive failure. Vertical loading, differential settlement forces, live load where applicable and all horizontal lateral and longitudinal forces shall be taken into account. Unbalanced temporary loading caused by placement sequence shall be provided for in the design. Adequate diagonal bracing in all planes shall be employed. The falsework drawings shall contain information on materials to be used and on procedures for erection.

When falsework installations are to be erected adjacent to a highway, special design consideration and protection shall be taken to ensure that the falsework system is not disturbed by errant highway vehicles or by the vibration forces caused by passing vehicles. Designs shall provide for protection against accidental collision of a crane boom or other construction equipment and vehicles, flood waters, high winds and any other envisioned contingent situations.

All designs and drawings for falsework systems shall provide for possible settlement and shall have adequate foundations with bearings below the frost line, on rock or piling. If additional subsurface data is necessary, it shall be obtained by the Contractor and analyzed by the P.E. for proper design of the falsework assembly and performance of construction, all at no additional cost to the District.

(B) SUBMITTALS - Prior to commencement of construction, designs for falsework shall be submitted for approval in accordance with 105.02. Work on the falsework shall not be started before approved plans are available.

The design calculations and working and erection drawings for falsework submitted by the Contractor shall be signed by the registered Professional Engineer (P.E.) who prepared these calculations and drawings and shall bear the P.E.'s seal. The submittal of the design and falsework drawings shall include the P.E.'s resume showing evidence of the required experience as heretofore specified.

The P.E.'s plans and design calculations shall evaluate and qualify all manufactured items for their intended service. Approval by the District of falsework systems shall not in any way relieve the Contractor of his/her responsibility for the safety and adequacy of the design and construction for the falsework systems and operations, including all components. The Contractor's contracts with his/her suppliers, subcontractors and manufacturers shall state their complete responsibility for the design and quality of their products and components including manufactured products and proprietary items.

(C) CONSTRUCTION - The Contractor shall not proceed with construction of falsework until approval of working drawings, submitted in accordance with 703.16(B) has been obtained from the District.

The falsework shall be constructed and maintained in accordance with the approved working drawings. Subsequent to approval any changes to the falsework design proposed by the Contractor through his professional engineer shall be resubmitted for approval in accordance with 703.16(B).

After assembly of the falsework system and before permitting any loads to be placed on falsework, the Engineer shall receive written certification by the Contractor's professional engineer that the falsework system has been erected according to the approved falsework drawings. This certification shall be accompanied by a Certificate of Compliance stating that all manufactured materials and assemblies fully comply with the falsework design and drawings. Upon inspection of the falsework system, the Engineer may require that testing be performed on any of the materials or assemblies. The costs of such testing shall be borne by the Contractor.

Falsework shall be set with the necessary camber so that the completed structure will be true to the lines and grades shown on the plans. A "telltale" or other approved type indicator shall be attached to the forms in a manner to indicate any settlement, movement or deflections in the forms or falsework. Should any indicator show settlement, movement or deflection in excess of the prescribed tolerance(s), the work shall be stopped and the Contractor shall be required to rectify the problem to the full satisfaction of the Engineer at the Contractor's expense.

In addition to protective measures shown on the falsework drawings, the Engineer may direct the Contractor to provide such further protection of falsework, which measures in the Engineer's judgement are necessary for public safety and protection of the work.

In the event falsework is moved from one structure to another, the falsework shall be thoroughly inspected and approved by the Contractor's Professional Engineer, (P.E). The falsework shall not be moved until the P.E.'s certification is reviewed and approved by the Engineer.

703.17 REMOVAL OF FALSEWORK AND FORMS

In the determinations of the time for the removal of falsework and forms, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of concrete, and the materials used in the mix. When stripping concrete forms is not controlled by means of cylinder strength, the following minimum periods, exclusive of days when the temperature drops below 40°F, may be used as a guide for removal of forms and supports which shall not be removed without the approval of the Engineer.

Walls, piers, footings, and side forms	12 to 24 hours
Floor slabs	8 to 14 days
Concrete superstructure, beams, arches	14 days

Rigid frames
Columns

14 days
2 to 7 days

Methods of form removal likely to cause overstressing of the concrete shall not be used. In general, forms shall be removed from the bottom upward. Particular care shall be taken in the removal of side forms before the concrete has attained considerable strength and hardness, to avoid breaking exposed edges or corners or spalling the surface.

703.18 CURING CONCRETE STRUCTURES

(A) GENERAL REQUIREMENTS. All concrete shall be cured and protected as specified herein. Before placing the concrete, the Contractor shall make all necessary arrangements for curing and protecting the concrete.

Concrete not covered by forms shall be cured using either of the following two systems for a period of seven (7) days:

(1) Two (2) layers of burlap meeting the requirements of 814.01, covered with one (1) layer of white polyethylene film, meeting the requirements of 814.02(A).

(2) One layer of burlap covered with one (1) layer of white burlap-polyethylene sheet meeting the requirements of 814.02(B).

The burlap and burlap portion of the white polyethylene film shall be saturated with water before it is placed in position, and maintained in a saturated condition by a continuous supply of water distributed by suitable means such as soaker hoses. The above described curing materials shall be placed as soon as it is determined by the Engineer that the concrete is hard enough to prevent marring during placement of the curing material. The curing materials shall be sufficiently secured to ensure that the entire area remains covered and wet for the required period.

Wood forms shall likewise be kept wet for the seven (7) day curing period.

At the ambient air temperature of 80°F (27°C) and below, the use of a resin-based pigmented liquid curing compound, meeting the requirements of 814.03, may be permitted immediately after final finishing of the concrete. Whether or not a curing compound is used, one of the abovementioned two (2) curing systems shall be applied as specified.

At ambient air temperatures between 80°F (27°C) and 85°F (29°C), the use of the resin-based pigmented liquid curing compound shall be required immediately after the final finishing of the concrete. One of the abovementioned two (2) curing systems shall be applied as specified as soon as it is determined by the Engineer that the finished concrete is hard enough to prevent marring during placement of the curing system.

The pigmented liquid curing compound shall be applied at a minimum rate of one gallon per 200 square feet. Application shall be such that an even, continuous membrane is produced on the concrete surface.

When directed by the Engineer, the Contractor shall be required to take precautions as specified in Section 2.1.5 of ACI 305R to prevent plastic shrinkage cracking.

The requirements of this section relative to keeping concrete surfaces saturated at all times will be strictly enforced. The Contractor shall furnish a sufficient water supply and personnel on a 24 hour basis to satisfy the

requirements specified herein.

(B) CONCRETE BRIDGE DECK SLABS. Concrete bridge deck slabs and other structural slabs shall be cured by using one of the following three (3) methods for a period of seven (7) days.

(1) Two (2) layers of burlap meeting the requirements of 814.01, covered with one (1) layer of white polyethylene film meeting the requirements of 814.02(A) shall be placed to assure that the entire deck surface is covered. The burlap shall be well secure at all times. A continuous supply of water will be required during the curing period to assure that the burlap and concrete surfaces are saturated at all times.

(2) One (1) layer of burlap covered by one (1) layer of white burlap-polyethylene sheet meeting the requirements of 814.02(C) may be used. The burlap-polyethylene shall be well secured to ensure that the entire deck surface will be covered at all times. A continuous supply of water will be required to assure that the burlap and concrete surfaces are saturated at all times.

(3) Cotton mats may also be used as a curing method. The cotton mats shall be well secured to ensure that the entire deck surface will be covered at all times. A continuous supply of water will be required to assure that the cotton mats and concrete surfaces are saturated at all times.

At an ambient air temperature of eighty (80) degrees Fahrenheit and below, the use of clear liquid curing compound immediately after finishing may be permitted. Whether a curing compound is used or not, one of the above three curing methods shall be applied as soon as it is determined by the Engineer that the finished deck concrete is hard enough to prevent marring during placement of the curing methods.

In areas where continuous dripping water from the deck may create problems and/or hazards to the public the Contractor shall be required to submit to the Engineer for approval alternate methods of curing or means of diverting the runoff water.

The requirements for keeping the concrete surfaces saturated at all times will be strictly enforced. The Contractor shall be required to furnish a sufficient water supply and personnel on a 24 hour basis to satisfy these requirements.

703.19 FINISHING EXPOSED CONCRETE STRUCTURES

(A) GENERAL. Forms of exposed surfaces shall be removed when permitted by the Engineer, without delay, to facilitate any necessary patching, cleaning or surface treatment as required herein to provide a satisfactory finished appearance.

After removing forms, all fins and irregular projections shall be removed from exposed surfaces. On all surfaces, cavities produced by form ties, and all other holes, honeycomb spots, broken corners or edges and other defects shall be thoroughly cleaned and saturated with water for not less than 3 hours immediately before repairs are made. They shall be filled with mortar composed of 1 part cement to 2 parts of fine aggregate by volume. The cement portion shall be composed of varying quantities of white cement mixed with the cement used on the job. Trial batches shall be made up and used for patching on concealed surfaces until a satisfactory matching color is obtained for use on exposed surfaces.

Any honeycombed concrete shall be chipped away to such depth that all voids have been entirely removed. The edges of the materials remaining in place shall be cut perpendicular to the finished surface to the average depth of the material removed, but not less than 1 inch. All surfaces of the cavity shall be thoroughly

cleaned and saturated with water. The cavity shall then be filled with concrete composed of the same kind of materials and proportions as in the surrounding concrete and shall be properly compacted. The concrete shall be cured as specified in 703.18.

(B) GROUT CLEANING. Unless otherwise specified in the contract documents, exposed concrete surfaces shall be grout cleaned as follows:

Grout made with 1 part portland cement and 1-1/2 parts fine sand and sufficient water to produce a consistency of thick paint, shall be applied uniformly to the concrete surface with brushes or spray guns so as to completely fill air bubbles and holes. White portland cement shall be used for all or part of the cement in the grout, as directed by the Engineer, to give the color desired. The surface of the concrete before applying the grout shall be sufficiently wet to prevent absorption of water from the grout. Immediately after applying the grout, the surface shall be floated with a cork float, scoring the wall vigorously. While the grout is still plastic, the surface shall be finished with a sponge rubber float, removing all excess grout. This finishing shall be done at the time when the grout will not be pulled from the holes or depressions. The surface shall then be allowed to dry thoroughly and then rubbed vigorously with dry burlap to completely remove any dried grout. There shall be no visible film of grout remaining after this rubbing. Upon completion of the grout cleaning, any dark spots or streaks shall be wiped off lightly with a fine abrasive hose without using water.

(C) ALTERNATE SURFACE FINISH. Brushed on coatings may be used in lieu of the grout cleaning if approved by the Engineer. A test panel shall be finished to determine the color and texture characteristics.

703.20 MASONRY BEARING AREAS AND ANCHOR BOLTS

(A) MASONRY BEARING AREAS. At the option of the Contractor, masonry bearing areas may be grouted, as herein set forth and shown on the plans; otherwise they shall be placed approximately 1/4 inch high and honed or ground level to within 1/16 inch (plus or minus) of proper elevation. Unless otherwise shown on the plans, when bearing plates are set on ground or honed surfaces, a sheet of lead 1/8 inch in thickness meeting the requirements of 815.11 with holes provided for anchor bolts or preformed fabric pads meeting the requirements of 815.11 with holes provided for anchor bolts or preformed fabric pads meeting the requirements of 821.02(A) with holes provided for anchor bolts, shall be placed between the masonry and the bottom of the plates.

If grouted, the bearing areas shall be set into the masonry surface 1 inch, so as to assure a pad edge thickness of at least 1 inch. Grouting methods shall be such that the entire space between masonry and plate is completely filled, and masonry bearing plates and shoes shall have full uniform bearing on the substructure masonry. They shall be carefully located and rigidly held to correct alignment and elevation during the grouting operation. With the permission of the Engineer, small holes may be drilled in the masonry plates to permit the escape of air trapped thereunder during grouting. The grout shall be non-shrink and the mix proportions shall be 1 part cement and 1-1/2 parts sand. Cement and sand shall first be thoroughly mixed dry before adding clean, fresh water to produce the required consistency. Grout shall be mixed only in those quantities required for immediate use. Grout that is not used within 45 minutes after water has been added shall be discarded. Retempering of grout will not be permitted. No superimposed load shall be placed on the bearing plates until the grout has set for at least 48 hours. No grouting shall be done in freezing weather. Grout shall be protected and kept moist for at least 3 days after grouting. After the grout has set sufficiently, the edges of the grout pad shall be finished to a slope of 45 degrees.

(B) ANCHOR BOLTS. All necessary anchor bolts in piers, abutments, or pedestals shall be accurately set in the concrete masonry as it is being placed, in holes formed while the concrete is being placed, or in holes

drilled after the concrete has set. If set in the masonry as it is being placed, anchor bolts shall be positioned by means of a suitable template and otherwise held rigidly in place by means of wires, blocks or other means satisfactory to the Engineer. The template shall be so arranged that the concrete bearing area, if poured high as specified herein, may be readily accessible for proper finishing.

Holes, if drilled, shall be at least 1 inch larger in diameter than the bolts used, or in accordance with the manufacturer's recommendations if epoxy compound installations are used. Holes shall be drilled utilizing a template to insure proper alignment. Holes shall be carefully cleaned after drilling to remove all drilling residue. Where dry drilling is employed, the holes shall be vacuumed or blown out using oil-free compressed air. Where the drilling process requires the use of water, holes shall be carefully washed out after drilling to remove any drilling slurry residue and then be permitted to dry prior to placing bolts. Provisions shall be made to protect unfilled holes against rupture in freezing weather.

The Contractor shall anticipate that reinforcing bars or utilities may be encountered while drilling holes in concrete. The use of diamond bit drilling or other special procedures necessary to drill through reinforcing bars shall be included as part of the work. The Contractor shall be responsible for any damage to electrical conduits, utilities or the structure. The repair of any damage shall be included as part of the work.

Anchor bolts and bolt holes shall be thoroughly clean and dry at the time of bolt installation. Any grease encountered shall be removed with toluene. The bolts shall be set accurately as to location and projection and fixed with grout completely filling the holes. The grout shall be a pourable epoxy mortar conforming to 806.05(C) and 821.10, Type II, Grade 1. Conditions and directions for use shall conform to the manufacturer's directions. Templates shall be used to hold the bolts in position until the grout cures. Temperatures at the time of installation shall be 35°F or above and both holes and bolts shall be free of frost. Curing temperatures of above 25°F shall be maintained.

Exposed portions of anchor bolts shall be thoroughly cleaned and painted within three days, but not less than eight hours after installation to protect the masonry from rust stains.

Anchor bolts for handrailing shall, unless otherwise required, be set in the masonry as it is being placed, positioned by means of templates and otherwise be held rigid as outlined herein.

Should the exposed portion of anchor bolts become dirty or rusty prior to setting the shoes, the Contractor shall thoroughly clean and paint the anchor bolts before setting shoes. All portions of anchor bolts and anchorage metal exposed after erection of shoes shall be painted as provided for in 707.

703.21 BRIDGE DECKS AND APPROACH SLABS

(A) GENERAL. All bridge deck concrete shall be placed in conformance with 703.07 and cured in conformance with 703.18(B).

(B) MACHINE FINISHING. Machine finishing of bridge decks and approach slabs is required. Equipment for finishing shall be in accordance with 905.06(B). A rolling bridge shall be located on the finishing machine rails behind the finishing machine for the use of the Contractor and for inspection and testing.

Prior to beginning concrete placement operations, the finishing machine shall be operated over the full area of the slab to be constructed. This test shall be made with the machine adjusted to its finishing position. While operating the finishing machine in this test, the screed rails shall be checked for deflection and proper

adjustment, the cover on slab reinforcement measured and controlling dimensions of slab thickness checked. All necessary corrections shall be made at least four (4) hours before concrete placement and operations begin.

After the concrete has been placed, spread, and consolidated to provide a uniformly dense structural slab, the surface shall be struck off immediately by the passage of the finishing machine. A sufficient quantity of concrete shall be in place in front of the auger to preclude low and porous areas. The oscillating travel of the auger and cylinder device shall be repeated as necessary to produce a uniformly consolidated, dense, smooth surface of the required contour.

After passage of the finishing machine, any irregular or unsealed surface shall be floated with a float meeting the requirements of 905.09(C). No water shall be applied to the slab surface during the finishing process.

Immediately after floating, the surface shall be tested for irregularities with a straightedge per 903.03. All slab sections shall be tested with a straightedge parallel to traffic flow. The straightedge shall be used to test the surface for longitudinal trueness. All depressions and high spots of more than 1/8 inch in 10 feet must be corrected as directed by the Engineer. If a surface fails to meet these tolerances, the Contractor shall correct the deficiency at the Contractor's expense. If testing the surface, successive positions of the straightedge shall be lapped 1/2 its length.

All depressions and high spots of more than 1/8 inch in 10 feet which exist in the hardened concrete shall be corrected in a manner as directed by the Engineer at the Contractor's expense.

(C) TEXTURING. Texturing is required for the entire concrete bridge deck and approach slab riding surfaces, except for a 12-inch wide gutter surface adjacent to the curb or face of traffic barrier. The purpose is to create a suitable skid resistant riding surface for the finished structure.

The method of bridge deck texturing by saw cutting grooves shall be used.

The grooving operation shall not be started until the bridge deck has been cured in accordance with the specifications and attained a minimum compressive strength of 3,000 psi. The bridge deck shall be grooved perpendicular to the center line.

The grooves shall be cut into the hardened concrete using a mechanical saw device which will leave grooves 1/8 in. wide, $3/16 \pm 1/16$ in. depth and variably spaced from 5/8 to 7/8 in. apart.

The grooves shall extend across the slab to within 1 ft. of the gutter lines. The transverse grooving shall not cut across joints, but shall stay clear by 2 ± 1 in. on each side.

Slurry from the grooving operation shall not be permitted to accumulate on adjacent lanes to the extent that it would create a slippery or hazardous condition. Solid residue resulting from grooving operations shall be removed from pavement surfaces. The removal of all debris (slurry, etc.) resulting from the grooving operations shall be continuous. Pavement shall be immediately left in a washed clean condition, free of all slipperiness from the slurry, etc.

All debris and surplus material removed from the grooving operations shall be deposited in a truck or other conveyance and removed from the project. The slurry shall not be disposed of in the existing drains or on the slopes of the roadway, but shall be removed from the project and disposed of by the Contractor.

703.22 SIDEWALK, MEDIAN AND CURB FINISH

Immediately after the concrete has been deposited in place, it shall be consolidated and screeded with a surface variation tolerance of 1/8 inch in 10 feet. The sidewalk and median surfaces shall be troweled to a dense, smooth surface, after which it shall be broomed transversely with a broom meeting the requirements of 905.09(D)(2), to produce a slightly roughened surface which will not be slippery.

All scoring shall be done with a jointing tool having a blade projection of 1/2 inch and minimum borders of one and 1-1/2 inches.

The jointing tool for scoring the line back of the curb shall be one piece to include the edge radius at the top of the curb. All borders shall be removed in the brushing operation.

Forms for curbs shall be designed so that they will not deflect more than 1/16 inch at any point during concrete placement.

On island noses and other short radius curbs form work shall be lined with 1/4 inch plywood or masonite or other approved liners.

The curb forms shall remain in place a minimum of 12 hours, and during periods of low temperatures (below 40°F), they shall not be removed in less than 36 hours. The forms shall be removed within 60 hours after the concrete has been deposited against them. After removal of the forms all fins and burrs shall be immediately removed and cavities produced by joints, projections and air pockets shall be filled by grout cleaning as specified in 703.19(B).

Curing of sidewalk, medians and curbs shall be as outlined for slabs in 703.18.

703.23 TOLERANCES

Where tolerances are not otherwise specified in the contract documents, deviations from the established dimensions will be permitted to the extent set forth below. The Contractor shall set and maintain concrete forms so as to insure completed work within the tolerance limits herein indicated.

(A) FOOTINGS.

1. Variations in dimensions in plan: Minus 1/2 inch to Plus 2 inches.
2. Misplacement or eccentricity: 2 percent of the footing width in the direction or misplacement but not more than 2 inches.
3. Reduction in thickness: Minus 5 percent of specified thickness.

Applies to concrete only, not to reinforcing bars or dowels.

(B) WALLS, PIERS, COLUMNS.

1. Variation from the plumb or the specified barrier: Exposed, 1/2 inch in 10 feet; Backfilled, 1 inch in 10 feet.
2. Variation in cross-sectional dimensions (also including beams: Minus 1/4 inch to Plus 1/2 inch.

(C) BRIDGE SLABS.

1. Variation in thickness: Minus 1/8 inch to Plus 1/4 inch.

703.24 CONCRETE BONDING WITH EPOXY

Where indicated on the plans, epoxy adhesive, conforming to 821.10(B)(1), shall be used to bond new concrete to old concrete. A manufacturer's certification that the material conforms to the specifications shall be submitted prior to use.

The application shall conform to the manufacturer's directions.

Concrete surfaces to be bonded shall be structurally sound and free from foreign materials. Sandblasting, either wet or dry, shall be used in preparing sound concrete surfaces for new concrete, and shall be performed in such a manner as to remove all dirt, grease, paint, loose and unsound concrete and other foreign material and expose a clean surface of sound concrete over the entire area to be treated. Suitable traps and filters shall be utilized with sandblast equipment to prevent oil from being deposited on surfaces.

Payment for epoxy bonding will be included in the price for the appropriate concrete bid item.

703.25 MEASURE AND PAYMENT

The unit of measure for the various items of concrete listed in the Schedule of Prices will be the cubic yard. The number of cubic yards will be the volume determined from the dimensions shown on the plans.

The volume of emblems, reinforcement, chamfers, conduits, boxes, metal pipe sleeves, scuppers, manholes, piling and other inserts will not be deducted from the gross volume measured.

The number of cubic yards of concrete measured will be paid for at the contract unit price per cubic yard for the various items of concrete listed in the Schedule of Prices, which payment will include emblems, reference marks, water stops, performed joint filler, poured joint seals, dove-tailed slots for stone anchors, bearing pads, and other similar materials, except for reinforcing steel. Also included will be all the labor, materials, tools, equipment and incidentals necessary for proportioning, mixing, forming, placing, finishing and curing the concrete. Included in the cost of Superstructure Concrete will be the setting of manhole frames and covers but not the furnishing of these items. Texturing of the surfaces of bridge decks and approach slabs is included in the cost of these items. Anchor bolts will be furnished and paid for under Structural Steel, Section 706. The setting of anchor bolts will, however, be included in the contract unit price for the respective class of concrete in which they are located.